"On the Application of the Kinetic Theory of Gases to the Electric, Magnetic, and Optical Properties of Diatomic Gases." By GEORGE W. WALKER, B.A., A.R.C.Sc., Fellow of Trinity College, Cambridge, Sir Isaac Newton Research Student. Communicated by Professor RÜCKER, Sec. R.S. Received January 23,—Read February 14, 1901.

(Abstract.)

The aim of this paper is to apply the method of "The Boltzmann-Maxwell Kinetic Theory of Gases" to the electric, magnetic, and optical properties of gases. For the sake of simplicity the molecule is supposed to consist of two atoms, so that the results apply to gases such as Hydrogen or Oxygen. Several of the results indicate, however, qualitatively what we might expect for more complex molecules.

One of the atoms is supposed to have a positive electric charge and the other an equal negative charge, and the force in play between the two atoms is taken as the ordinary electrostatic force.

It is contended that the molecules may be classified into three types—(1) that in which the two atoms rotate in contact; (2) that in which the two atoms revolve in elliptic orbits about their C.G., but not in contact; (3) that in which the two atoms move in hyperbolic orbits for the short time during which they influence each other appreciably. They may thus be regarded as practically free.

The first portion of the paper is concerned with calculations respecting the relative proportions of these three sets; and although a quite complete solution is not obtained, the results indicate certain important features, and may prepare the way for a more complete investigation.

It is next shown that such a system will exhibit magnetic properties, and the *coefficient of magnetic susceptibility* is calculated. The formula obtained shows a close agreement with Professor Quincke's experiments on this question.

The system will also exhibit electrical properties. *The dielectric constant* is calculated. The formula differs essentially from other theories of electric susceptibility, *e.g.*, Boltzmann's, in the *important dependence on temperature*. A note at the end of the paper, giving some recent experimental results by Herr Karl Baedecker, shows how closely the theory agrees with his experimental observations of the temperature effect.

The electrical conductivity is calculated as depending on the number of free atoms present. Reference is also made to a paper by the author, communicated to the Physical Society of London, in which it is shown how the formation of striæ in a vacuum tube may be accounted for.

The optical properties are next considered, and the amount of *refraction produced by free atoms and molecules* calculated. The calculations on the free atoms are of interest, inasmuch as it is shown that they *accelerate the velocity* with which waves are transmitted. With regard to the molecules, it is shown that the *optical control may be regarded as due to* $\bar{\omega}^2$, the mean value of ω^2 for the molecules, where ω is the angular velocity of rotation of the two atoms about their common C.G. Dispersion is also accounted for, and *depends essentially on the distribution law of velocities.* The effects of radiation from the molecules are also considered in the course of the work.

The *rate of rotation of the plane of polarisation in a magnetic field* is also calculated, and the sign of the rotation shown to depend on which atom has the larger mass. If the masses are equal no rotation is produced. The work borders in some ways with Professor W. Voigt's investigations.

The formulæ obtained are applied to the case of oxygen to obtain estimates of e/m_1 and e/m_2, e being the charge and m_1 and m_2 the masses of the two atoms. An estimate of $\bar{\omega}$, and hence of $2r_0$, the sum of the radii of the two atoms, is also obtained. *The value of* e/m_1 *agrees closely numerically with this ratio obtained from electrolytic considerations, while the value of* e/m_2 *agrees closely with the value obtained from considerations of the Zeeman effect.*

February 21, 1901.

Sir WILLIAM HUGGINS, K.C.B., D.C.L., President, followed by The LORD LISTER, F.R.C.S., D.C.L., Vice-President, in the Chair.

A List of the Presents received was laid on the table, and thanks ordered for them.

The following Papers were read:—

I. "An Attempt to Estimate the Vitality of Seeds by an Electrical Method." By Dr. A. D. WALLER, F.R.S.

II. "On a New Manometer, and on the Law of the Pressure of Gases between 1·5 and 0·01 Millimetres of Mercury." By LORD RAYLEIGH, F.R.S.

III. "An Investigation of the Spectra of Flames resulting from Operations in the Open-hearth and 'Basic' Bessemer Processes." By Professor W. N. HARTLEY, F.R.S., and HUGH RAMAGE.